

NERVE-STRETCHING.

SELECT TOPICS OF MODERN SURGERY,* ILLUSTRATED BY CASES
FROM THE HOSPITAL SERVICE AND PRIVATE
PRACTICE OF

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THIS operation has been known for only about half a decade. It was originated accidentally by Billroth, who cut down upon the sciatic nerve, expecting to find a tumor, but found nothing but normal nerve-tissue. By this very examination, however, the neuralgia was relieved. Nerve-stretching as a premeditated surgical operation was first carried out by Von Nussbaum, in Munich.

The unexpected success in relieving pain by this operative procedure in cases in which all other remedies have failed, and the almost absolute immunity, not only from danger to the patient's life, but also from the destruction or impairment of the normal functions of the nerve operated upon, caused this operation to be very readily adopted by medical men all over the world.

There are already a number of facts at our disposal which throw considerable light upon the therapeutic value of the operation in certain diseases of the nerves.

As our knowledge of the subject is as yet very imperfect,

*This is the general heading of a series of articles published in different American journals, and is kept up as such, because it is the intention of the authors, after a certain length of time, and after revision, correction, and addition, to publish the series in one volume.

owing to the scarcity of pathologico-physiological experiments on animals, we shall here give only a brief account of the various nervous diseases in which nerve-stretching has been tried, and point out the results, as far as known, but shall not be able to state anything about either the pathologico-anatomical or the pathologico-physiological side of the question.

From a merely clinical point of view, the different nervous diseases in which nerve-stretching has been tried are the following:

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| I. Neuralgic Anomalies. | { | 1. Sciatica. { <i>a.</i> Rheumatic, idiopathic or primary.
<i>b.</i> Symptomatic or secondary. |
| | | 2. Prosopalgia. Neuralgia of the fifth pair. |
| | | 3. Intercostal neuralgia. |
| | | 4. Idiopathic neuralgias of other nerves. |
| | | 5. Neuralgias of the peripheral nerves caused by surgical lesions involving the nerve-trunks. |
| II. Spastic Anomalies. | { | 1. Mimic spasm. Spasms of the seventh pair. |
| | | 2. Spasms of the accessory nerve of Willis. |
| | | 3. Spastic contractions of the nerves of the extremities. |
| III. Epilepsy. | | |
| IV. Paralysis. | | |
| V. Tetanus. | | |
| VI. Locomotor Ataxia. | | |
| VII. Anæsthetic Leprosy. | | |

I. NEURALGIC ANOMALIES.

I.—SCIATICA.

a. Rheumatic, Idiopathic or Primary Sciatica.

We have had at our disposal reports of ten cases of nerve-stretching in this disease, eight of which were successful and two unsuccessful (Bernays).

CASE 1.—(John Cheyne, Edinburgh, 1877.^{1, 2}) A furnace-man, forty years of age, suffered for five years from pain and weakness in the right leg, which increased to such an extent that he became unable to walk. On April 19, 1877, the sciatic nerve was stretched. The nerve appeared perfectly normal. The operation was followed by perfect recovery.

CASE 2.—(John Cheyne, Edinburgh, 1877.^{1, 2}) A furnace-man, forty-one years of age, had suffered from sciatica of the left side for ten months. The sciatic nerve was exposed and stretched April 23, 1877. The nerve appeared to have undergone fatty degeneration, and large, tortuous veins were to be seen on its surface. The pain disappeared entirely, with the exception of a

small place behind the great trochanter, where pressure still caused a little pain.

CASE 3.—(Maag, Denmark, 1878.³) A girl, nineteen years old, suffered from sciatica of three months' standing. The nerve was stretched. The wound did not heal by first intention. Recovery.

CASE 4.—(Patruban, Vienna, 1878.⁴) Sciatica. Stretching of the sciatic nerve, followed by great amelioration of the symptoms.

CASE 5.—(Bernays, St. Louis, Missouri, 1878.⁵) A man had suffered for six or eight months from severe neuralgic pains on the outer aspect of the thigh. The sciatic nerve was stretched immediately above the knee. The pain was relieved for six days, but then returned. One and one-half inches of the peroneal and external saphenous nerves were excised. This operation was followed by entire relief of the pain, but the muscles remained paralyzed.

CASE 6.—Dr. Bernays mentions another case, without giving particulars, in which nerve-stretching proved to be a complete failure.

CASE 7.—(Hildebrandt, Neustadt-Magdeburg, 1880.⁶) A woman, thirty-two years of age, suffered from sciatica of the left side. The sciatic nerve was stretched in the popliteal space. The wound healed by first intention. The operation was followed by immediate relief, and the patient, after eight days, was able to do her own work.

CASE 8.—(Esmarch, Kiel, 1880.⁷) Sciatica. Nerve-stretching. Recovery.

CASE 9.—(Purdie, London, 1880.⁸) Severe sciatica of several months' standing, in a miner. The sciatic nerve was stretched. The wound healed by first intention. Recovery.

CASE 10.—(Fenger, Chicago, 1880.) SYNOPSIS.—*Sciatica of one year's standing—Stretching of sciatic nerve between the great trochanter and the tuber ischii—Wound healed by suppuration in eight weeks—Cessation of pain in the leg—Temporary paralysis of the sphincter ani and anæsthesia of anal region and posterior surface of both thighs—Recovery.* Mrs. H., thirty-five years of age, healthy, stout, has two healthy children, aged, respectively, seventeen and eighteen years. Her father suffered from sciatica of the left side at the age of forty-five, which lasted a year, confining him to his bed for six months, and finally disappeared after treatment by sea-baths. Her sister had sciatica at the age of thirty. Her father died of cancer of the liver, at the age of fifty.

Her mother is still living, and healthy, with the exception of occasionally recurring muscular rheumatism.

In June, 1879, while crossing the Atlantic, Mrs. H. was seized with pain in the right side of the head, face, and neck, and in the right arm. An ointment was applied, and the pain disappeared in two or three weeks.

November, 1879.—The patient awoke one night with a sudden and violent pain in the right ankle, which she could trace to no inducing cause. She was obliged to keep her bed for eight days. Under the use of morphine and some ointment, the pain lessened so that she was able to be up and around.

During the whole of the following winter she was able to walk the whole day long on level ground without pain, but when mounting stairs, pain would set in, always at the same place, around the external malleolus, at which, however, no swelling nor other inflammatory symptoms were to be seen. Every night she would be awakened several times by vehement pain in the ankle, caused, as she thinks, by moving the leg during sleep. In this way it went on until June, 1880, when pain set in in the right knee and soon extended along the posterior part of the femur to the hip, so that she was not able to extend the leg at the knee, and could not walk without limping. When she got out of bed in the morning the pain was very severe, but would lessen after she had walked around a little. She would soon become tired and be obliged to sit down, and when she would start to walk again the pain would be very severe. She was not able to walk more than about two thousand feet before the pain would become so intense as to compel her to sit down. Various kinds of internal medication, hypodermic injections of morphine, and Turkish baths were tried, but with no effect. The pain became worse and she had more and more difficulty in walking, until she finally determined to have the proposed operation performed.

On October 6, 1880, Dr. Fenger, assisted by Drs. Jacobson and Koren, proceeded to stretch the right sciatic nerve. The patient was anæsthetized with chloroform. An incision was made, four inches in length, between the great trochanter and the *tuber ischii*. The layer of adipose tissue was about one inch in thickness. The depth of the wound and the hemorrhage caused a little delay in finding the trunk of the nerve, which, when found, appeared normal. The nerve was now stretched vigorously, centrally as well as peripherally, and pressed between the fingers and the instrument with which the nerve was held out of the wound, namely,

an elevator of the palpebræ used as a retractor. The wound was washed out with two and one-half per cent. solution of carbolic acid, until the hemorrhage ceased. No drainage tube was inserted. The wound was closed with antisepticized silk and Lister dressing applied.

The wound did not heal by first intention, but suppuration set in, which prevented it from healing for eight weeks, during which time the patient was obliged to remain in bed.

The pain in the thigh and knee ceased entirely and has not since returned, and the knee could be fully extended without pain; but for seven weeks after the operation there were intercurrent attacks of pain around the right malleolus, which were controlled by morphine, and after the above-named period ceased entirely.

Four weeks after the operation, when lifting herself upon the bed-pan, she experienced a sudden and vehement pain in the sacral region, and radiating down the posterior surfaces of both thighs. After two days this pain ceased, but complete anæsthesia around the sacrum, the nates, and rectum, and down the posterior surfaces of both limbs remained. Injections in the rectum would not be felt, and for four weeks the passages were involuntary. There was also a strong tendency to incontinence of urine.

Eight weeks after the operation the wound was healed, and the patient was able to get out of bed, but she had to use crutches for four weeks.

Sitting on a hard chair would cause severe pain in the sacral region, which would be relieved only by sitting upon an inflated rubber bed-pan.

The sacral region and nates were in no place tender on pressure, and the skin covering them was so completely anæsthetic that a hypodermic injection of morphine would not be felt at all.

After four weeks' exercise on crutches, during which time the right leg was somewhat weak, but otherwise painless, she became able to walk with a cane, which she was obliged to use for about two weeks. Slight œdema around the malleoli of the right leg would show itself evenings and disappear in the mornings.

Now, March 4, 1881, the patient is able to walk around the whole day, and has no pain whatever in the leg, even after walking two miles. When she gets tired after such a walk, she will sometimes feel a pricking sensation along the posterior side of the leg, and occasionally, in bad weather, slight pain in the ankle. When she sits more than two hours in a hard chair, she feels pain

in the sacral region. The usual sensation with the passages is not quite normal. No fæcal matter will pass involuntarily, but sometimes, when coughing, flatus will pass without her knowledge. There is incomplete anæsthesia along the external border of the foot and external malleolus, on the nates, and the upper part of the posterior surface of the right thigh. The sensibility of the remainder of the lower extremity is normal and the muscular strength natural.

In this rheumatic or idiopathic sciatica, nerve-stretching may be considered to have had good results, and so much the more, since the cases in which it has been resorted to have been obstinate, of from three months' to fifteen years' duration, and the operation has been, so to speak, the *ultimum refugium*, every other mode of treatment having, in most of the cases, been tried in vain before the operation was resorted to. The operation, furthermore, has been so far successful in this disease, that in eight of the cases the one operation was sufficient, and no renewal of the stretching was necessary.

The localities in which the nerve has been stretched for sciatica are: 1. The popliteal space, posterior to or above the knee joint (Bernays, Von Nussbaum, and Hildebrandt); or more commonly, 2. The *inscissura sciatica*, that is, the space between the great trochanter and *tuber ischii*, where the nerve comes down from beneath the *gluteus maximus*, is covered only by the skin, and rests upon the *quadratus femoris* muscle. The latter locality is by far the most convenient for the performance of the operation, partly because the trunk of the nerve is easily found, and partly because a comparatively unskilled operator may perform the operation without risk, as the vessels which accompany the nerve are insignificant in size. The operation in the *inscissura sciatica* has, moreover, the advantage that the nerve-trunk is stretched at a point not far distant from the nerve-centre. Langenbuch advises to stretch the nerves as near the centre

as possible, even if it is not known in what part of the nervous system the action is needed. This renders it more certain that all the nerve-fibres affected will be reached by the operation. In the operation in the popliteal space, there is some danger even for the skilled operator, as has been demonstrated in a case reported by Von Nussbaum, in which, although the operation had been performed without accident, hemorrhage set in two weeks later, caused by ulceration through the walls of the popliteal vein, produced by the pressure of the drainage tube.

As to the amount of force which should be employed to stretch the nerve effectively, it is in this, as in all cases of nerve-stretching, impossible to give specific rules for the guidance of the operator. From experiments on dead bodies we know that the average weight required to break the sciatic nerve asunder is one hundred and thirty pounds (Johnson, Lymington⁹). On another occasion the sciatic nerve was thoroughly stretched by taking it out of the wound and lifting it so that the leg was also raised.

The advice most generally given, and probably the best, is to pull on the nerve-trunk successively, both in the peripheral and central directions, long and vigorously, until a sensation as of something giving way in the trunk of the nerve is experienced. Care must of course be taken to cease stretching when this sensation is experienced, so as to avoid a rupture of the nerve-trunk. The danger of rupture is, however, not very great, as no case is as yet on record. The same method may be pursued in the stretching of other nerves.

b. Symptomatic or Secondary Sciatica.

This disease is characterized by pain in the territory of the sciatic nerves, dependent upon or complicated with lesions of the spinal cord. In such cases, as might be

expected, nerve-stretching has not been as successful as in the former class. Out of seven cases only one complete recovery is reported (Andrews); in five cases greater or less complete relief followed the operation; and in one case (Czerny) no effect at all was experienced.

From another standpoint than that of cure of the disease, which in this affection is generally out of the question, it must be admitted that the operation has even here not been performed in vain, for by it the sufferings of the patients have been relieved in great measure. We consider that the good results obtained by this operation have been amply sufficient to compensate for the inconvenience to the patient, due to the operation itself.

CASE 1.—(E. Masing, St. Petersburg, 1878.¹⁰) A working man, thirty-seven years old, had suffered for eight years so severely from neuralgia in both extremities that he was about to commit suicide. For seven years he had been going from one hospital to another without obtaining relief. The muscles of both legs were atrophic; almost complete anæsthesia existed in the territory of the sciatic nerves of both sides; the muscles of the legs and feet were paretic; defecation was sometimes spontaneous, and micturition difficult. The sciatic nerves of both sides were stretched, under antiseptic precautions. Violent pain was experienced in the first week after the operation. During the second week the pain gradually diminished, and the anæsthesia and paresis lessened.

Two months later the left crural nerve was stretched on account of pain on the anterior side of the thigh. The final result was that the anæsthesia and pain entirely disappeared, and the paresis was ameliorated until there remained only slight disturbance of motion in the ankle joints and toes. The urinary trouble, however, continued.

CASE 2.—(E. Masing, St. Petersburg, 1878.¹⁰) A boy, ten years of age, after a fall on the sacral region, suffered from contractures of the muscles of the left leg, so that the foot was fixed in the position of *pes varus*. There was no active mobility whatever; passive movements caused pain; there was general hyperæsthesia of the skin of the foot and leg; tenderness on pressure

along the sciatic nerve. During sleep and narcosis the spastic contractures relaxed. All other means having been tried in vain, nerve-stretching was resorted to. Immediately after the operation the symptoms increased, and no amelioration set in for seven weeks, after which time the pain and spasms gradually diminished. Seven months afterward the patient's condition was a little better, but he still had pain and was unable to walk.

CASE 3.—(Edmund Andrews, Chicago, 1876.⁴) A sailor, who had fallen down a year previous to the operation and fractured two ribs and the right thigh, subsequent to this injury suffered from paresis and anæsthesia of both lower extremities. When brought into Mercy Hospital he complained of spastic contractions and severe pain when his legs were extended; the main symptom being constant tonic spasms of the *adducti* of both thighs, the contraction being caused, among other things, by touching the glans penis. In narcosis carried out even to complete anæsthesia of the cornea, extension of the lower extremities would cause these spasms to set in. On May 15, 1876, the left sciatic and crural nerves were stretched. After the operation the symptoms on the right side ceased, and when on May 24, 1876, the same operation had been performed on the right side, the spasms of the left leg ceased. The cure was perfect seven months after the second operation, so far as known; so far perfect, at least, as to enable the patient to perform a sailor's duties on his passage from America to England.

CASE 4.—(Czerny, 1879.¹¹) Neuralgia in the sciatic nerves of both sides from myelitis, caused by compression, in a case of Pott's disease of the vertebral column. The sciatic nerves were stretched with no perceptible result.

CASE 5.—(Trendelenburg, Rostock, 1880.⁷) Sciatica consequent upon spinal injury. The sciatic nerve was stretched with incomplete effect.

CASE 6.—(Fenger, Chicago, 1880.) SYNOPSIS.—*Severe sciatic pain of four months' standing, in a case supposed to be central cancer of the bones of the pelvis—Stretching of the sciatic nerve—Cessation of the pain—Progressing cachexia and debility—Death.* Miss Fogarty, unmarried, forty-five years of age, came under the care of Dr. Fenger December 10, 1880. Family history good. She had had no severe illness previously, but had always been rather lean and nervous. Four months previous she was seized with what she believed to be rheumatic pains at the external and posterior side of the left hip, and from there radiating upward along the right half of the sacrum to the lumbar region, and downward

along the posterior side of the thigh to the knee joint. The pain, at first slight, made it difficult for her to walk, and two months later she was obliged to go around on crutches, as the pain became unbearable when the limb touched the ground.

Many kinds of internal and external treatment were tried by different physicians, but the pain steadily increased, and paroxysms set in even when she was sitting or lying down, so that she was not able to sleep at night, and the pain could not be controlled even by large doses of morphine. During these four months her appetite was poor, and she decreased considerably in weight.

On examination, December 10th, the patient was lying on an adjustable folding chair, the left leg slightly flexed on the hip-joint, and resting on pillows. The slightest movement from this position would cause intense pain. Pressure upon the great trochanter would also cause pain, as well as pressure anterior to the joint. No swelling around the hip. The patient was considerably emaciated. Pulse and temperature normal. Lungs, heart, and abdominal organs normal. The urine contained neither albumen nor sugar. The bowels were habitually constipated. There were no signs of paresis or anæsthesia in any part of the lower extremities.

As the pain was mainly localized around the hip-joint, and the patient would submit neither to an operation nor to an examination in narcosis, extension by means of a weight and pulley was tried, to relieve the pain in the hip. For about a week it seemed as if this treatment would relieve the pain, as the patient was able to rest in bed night and day, and suffered much less at night, but in the second week severe paroxysms of pain set in, just as before the extension, and could not be controlled by hypnotics of any kind. She then consented to have an examination made in narcosis, and then, if the hip-joint was found healthy, to have nerve-stretching performed at the same time. Consequently, preparations were made, and on January 6, 1881, Dr. Fenger, assisted by Dr. Dudley, performed the operation.

The patient was anæsthetized with ether; the hip-joint was found perfectly movable; the sciatic nerve was cut down upon between the great trochanter and the *tuber ischiæ*, taken out without difficulty, stretched vigorously both in the central and peripheral directions, and, after having been compressed and rolled between the finger and the retractor with which it was lifted from the wound, it was replaced, a drainage tube inserted, the wound united with aseptic silk, and Lister dressing applied.

The spontaneous pain in the legs disappeared entirely from the time of the operation, so that the patient could rest in bed and sleep all night long, but active and passive movements of the lower extremity would still cause pain on the posterior side of the hip and in the lumbar region. For three days after the operation there was incessant vomiting, which afterward disappeared. Pulse and temperature were always normal. Four days after the operation the drainage tubes and sutures were removed. Eight days after the operation the Lister dressing was removed, and the wound healed by first intention. In the course of the following four weeks the patient wasted gradually; the appetite, previously poor, disappeared entirely; in the meantime the pulse and temperature continued normal. She would sleep at night and part of the day, without hypnotics, and never complained of any pain except when moved to have a passage of the bowels or an injection. In the second week of February she became somnolent, apathetic, no rise in temperature occurring at any time, and died February 12th. An autopsy was not permitted.

CASE 7.—(Fenger, Chicago, 1880.) SYNOPSIS.—*Severe pains in region of left sciatic nerve, in a case of obscure, central nervous disease—Nerve-stretching—Healing by first intention—Cessation of pain—Progress of the original disease—Death.* P. N., an Irishman, about sixty years of age, was transferred August 5, 1880, from the medical to the surgical side of Cook County Hospital, and put under Dr. Fenger's care, with a view to the performance of nerve-stretching for supposed sciatica. The patient was greatly emaciated, and absent-minded or idiotic, so that he was not able to give any history of his case. He complained of severe pain on the posterior side of the left hip-joint, radiating from this point down the posterior side of the thigh. This pain set in in frequent paroxysms, and did not allow him to sleep at night. The pulse and temperature were normal; the heart, lungs, and abdominal organs normal; urine normal. His mental condition was one of stupor. He would sometimes pass urine and fæces involuntarily in bed, and his appetite was poor.

August 7, 1880.—Dr. Fenger stretched the left sciatic nerve in the manner described above. No drainage tube was inserted. The wound was united by aseptic silk and Lister dressing applied. The wound healed by first intention in eight days. The spontaneous paroxysms of pain ceased, but the patient wasted away gradually, and died four weeks later, without any notable change in the symptoms. An autopsy was not permitted.

2.—PROSOPALGIA, OR NEURALGIA OF THE FIFTH PAIR.

The branches of the fifth pair, operated upon in the recorded cases, have been the supra-orbital and infra-orbital of both sides in one case; supra-orbital and infra-orbital of one side, two cases; infra-orbital and mental of one side, one case; supra-orbital, four cases; infra-orbital, three cases; and inferior dental, one case.

Complete relief was experienced in nine cases, partial relief in one case, and no effect in two cases. In the case in which partial relief was experienced, the pain returned a few weeks after the operation. In two of the cured cases, temporary painful sensations were felt; in one case immediately, and in another twice during the first year, after the operation. In three cases nerve-stretching was combined with excision. In one case, after nerve-stretching had been performed with no effect, the nerve was divided and relief followed. The duration of the disease varied from seven months to ten, and in one case to fourteen years. Sensibility returned in the territory of the nerve operated upon, almost immediately in two cases, after two months in one case, and after five months in one case.

CASE 1.—(Vogt, 1876.⁴) Stretching of inferior dental nerve for neuralgia, followed by recovery.

CASE 2.—(Croftt, London, 1877.¹³) Convulsive neuralgia in the territory of the infra-orbital nerve. Five-eighths of an inch of the nerve was excised, and the nerve stretched. During the first year after the operation, two light attacks of the neuralgia were experienced. After that time the recovery was complete.

CASE 3.—(Charles Higgins, 1879.¹⁴) The patient was a man, 62 years of age, who suffered from neuralgia of the left supra-orbital and infra-orbital nerves subsequent to extirpation of the eye. These nerves were stretched. The operation resulted in perfect recovery, and sensibility soon returned.

CASE 4.—(Higgins, 1879.¹⁴) A man, 53 years of age, suffered from neuralgia of the right supra-orbital nerve after extirpation of the eye. The nerve was stretched, with the result of permanent relief from the pain, and a speedy return of sensibility.

CASE 5.—(Kocher, Berne, 1879.¹⁵) A cigarmaker, 32 years of age, had suffered for fourteen years from neuralgia of the right supra-orbital nerve. Nerve-stretching was performed, resulting in immediate recovery and the return of sensibility in two months.

CASE 6.—(T. Grainger Stewart, 1879.¹⁶) A man, 70 years old, suffered from neuralgia of the second branch of the left trigeminal nerve, combined with clonic spasms in the facial muscles of the same side. The left infra-orbital nerve was stretched with no effect. The same nerve was afterward divided, but no relief from pain was experienced. Finally, the left mental nerve was stretched, and the pain and spasms were permanently relieved.

CASE 7.—(Czerny, 1879.¹¹) Neuralgia of the supra-orbital and frontal nerves. The nerves were stretched without effect. Two weeks later resection was performed, followed by the use of electricity. This treatment resulted in complete relief.

CASE 8.—(Masing, St. Petersburg, 1879.¹⁷) A lady, 60 years of age, had suffered from severe supra-orbital neuralgia for about three years. The supra-orbital nerve was stretched, and the patient recovered. For one week after the operation chemosis and diffuse superficial keratitis were noticed, and anæsthesia of the forehead and cornea continued for eight months.

CASE 9.—(Hahn, Berlin, 1880.⁷) In a case of supra-orbital and infra-orbital neuralgia nerve-stretching was resorted to with no effect.

CASE 10.—(Purdie, London, 1880.⁶) The patient had suffered for years from epileptiform neuralgia of the second branch of the fifth pair. A transverse incision was made, and the infra-orbital nerve stretched by means of a blunt hook. This operation was followed by relapse. After five days the nerve was again stretched, and complete relief resulted.

CASE 11.—(Von Nussbaum, Munich, 1880.) Neuralgia of the supra-orbital and infra-orbital nerves of both sides. Nerve-stretching and excision of the nerves affected were performed. Relief for a few weeks followed the operation, but the patient soon suffered relapse on the left side.

CASE 12.—(Walsham, 1881.¹⁷) A woman had suffered for more than ten years from severe pain in the territory of the infra-orbital nerve. The nerve was stretched at its point of exit from the infra-orbital foramen. The operation was followed by erysipelas, in the course of which two slight attacks of pain were experienced; after this the patient's recovery was complete. Five months after the operation no relapse had occurred.

3.—INTERCOSTAL NEURALGIA.

CASE 1.—(Von Nussbaum, Munich, 1878.^{7,18}) A man, 20 years old, suffered from severe neuralgia on both sides, extending from the sternum to the umbilicus. Incisions were made, on both sides, along the external border of the *rectus abdominis* muscle, and the eighth, ninth, and tenth intercostal nerves exposed and stretched. Temporary relief was experienced. A relapse followed, and no further history of the case is reported.

4.—IDIOPATHIC NEURALGIAS OF OTHER NERVES.

Five cases of nerve-stretching in this class of diseases have been recorded, two of which resulted in complete recovery, while in three cases the relief obtained was only partial.

CASES 1, 2, and 3.—(Langenbuch, Berlin, 1880.⁷) Brachial neuralgia. The brachial plexus was stretched, with, in each case, only partial relief.

CASE 4.—(Hildebrandt, Neustadt-Magdeburg, 1880.⁶) A man, 32 years of age, complained first of stiffness of the fingers of the right hand; later, of pain along the inner surface of the forearm, which afterward extended up the arm and right side of the neck. The brachial plexus was stretched, and the patient obtained immediate and permanent relief.

CASE 5.—(Schüssler, 1880.¹⁹) A lady, 53 years of age, had suffered for three years from severe neuralgia in the right half of the occipital region. The trunk of the occipitalis major nerve was laid open, from the place where it passes through the trapezius muscle up to the *spina occipitalis externa*. The sheath of the nerve was thickened and injected. The nerve was then taken out from the sheath, taken between two fingers, and stretched vigorously in both directions. The wound was closed, and antiseptic dressing applied. A few slight attacks of pain occurred during the first three days, after that time the recovery was complete. The wound healed by first intention.

5.—NEURALGIAS OF THE PERIPHERAL NERVES CAUSED BY SURGICAL LESIONS INVOLVING THE NERVE-TRUNKS.

This class of neuralgias is represented by eleven detailed cases, of which eight were cured, two improved, and one a

failure. In one case it was necessary to stretch the nerve a second time before relief was secured. The nerves stretched were the following: Brachial plexus, one case; recovery. The median nerve, three cases; two recoveries and one partial relief. The ulnar nerve, two cases; one complete and one partial recovery. The sciatic nerve, two cases; two recoveries. The digital nerve, one case; recovery. The peroneal nerve, one case; recovery. Nerves of the testicle, one case; no effect.

Besides the eleven cases reported here, it must be mentioned that Esmarch has performed nerve-stretching several times (the exact number is not given) in cases of neuralgia following amputation, namely, in painful amputation-stumps, with invariable success. It seems, therefore, possible that in these obstinate cases nerve-stretching may supplant the former treatment of excision of the scar of the stump, or re-amputation.

It has been ascertained that the radial nerve of an adult requires an average weight of 84 pounds to break it asunder.

CASE 1.—(Callender, London, 1875.⁸) Neuralgia in the territory of the median nerve, of one year's duration, subsequent to amputation of the hand on account of injury by a circular saw. The median nerve was stretched, and the patient obtained permanent relief.

CASE 2.—(Maag, Denmark, 1878.³) A girl, 23 years of age, suffered from pain in the region of the sciatic nerve, of eighteen months' duration, subsequent to an abscess of the thigh. The sciatic nerve was stretched; the wound did not heal by first intention. Recovery.

CASE 3.—(Maag, Denmark, 1878.⁴) Intermittent neuralgia and contracture of the thumb and forefinger of the right hand, subsequent to a punctured wound of the hand. The median nerve was stretched in the *sulcus bicipitis*, and the patient recovered.

CASE 4.—(Vogt, 1878.⁴) Neuralgia after wound on the inner side of the right forearm, involving the ulnar nerve. The incision was made in the scar, and the ulnar nerve dissected out and

stretched. The operation was followed by immediate and permanent relief.

CASE 5.—(Czerny, 1879.¹¹) Neuralgia subsequent to suppuration around elbow joint. The ulnar nerve was stretched in the axillary plexus. The patient's condition was ameliorated, but the recovery was not perfect.

CASE 6.—Estlander, 1879.²¹) After a bullet wound through the arm the patient suffered from neuralgia in the territory of the median nerve. The nerve was stretched, and the pain ceased for 24 hours. This was followed by a relapse for three weeks. After this time the pain gradually decreased, but the recovery was not perfect.

CASE 7.—(Küster, Berlin, 1880.⁷) Sciatica consequent upon bullet wound. The sciatic nerve was stretched without effect. Nerve-stretching was repeated, followed by recovery.

CASE 8.—(Purdie, London, 1880.⁸) Neuralgic pain in the index finger subsequent to suppuration under the nail. The digital nerves were stretched; the pain ceased and has not returned.

CASE 9.—(Esmarch, Kiel, 1880.⁷) The peroneal nerve was stretched on account of neuralgia. The operation was followed by recovery.

CASE 10.—(Esmarch, Kiel, 1880.⁷) Neuralgia of the testicle after castration. The external spermatic nerve was stretched, but the operation gave no relief to the pain.

CASE 11.—(Crédé, 1880.²²) Ascending neuritis in the territory supplied by the left radial nerve, following traumatic injury. The radial, median, ulnar, and cutaneous axillary nerves were stretched, and the pain, which had been intense for eighteen months, was immediately and permanently relieved.

II.—SPASTIC ANOMALIES.

I.—MIMIC SPASM. SPASMS OF THE SEVENTH PAIR.

The five cases of mimic spasm on record were all cured by nerve-stretching. The disease was of from two to eight years' standing. The paralysis following the operation lasted, in the four cases in which it was reported, respectively two weeks, eight weeks, two months, and five months. In one case the nerve was stretched anterior to the ear, below the zygomatic arch. In the other cases a more central incision was made, that is, below or behind the ear.

CASE 1.—(Baum, Danzig, 1878.²³) A woman, 35 years old, suffered from spasms in the muscles of the left side of the face, subsequent to epileptiform attacks. An incision was made, anterior to the ear, and the seventh nerve stretched. The operation was followed by paralysis for two weeks, after which time the recovery was perfect.

CASE 2.—(Schüssler, Bremen, 1879.²⁴) A lady, 39 years of age, had suffered for eight years from spasms in the left half of the face and soft palate. The trunk and descending branch of the seventh nerve were vigorously stretched. The relief was instantaneous; a slight paralysis continued for eight weeks. Two months after, there had been no relapse.

CASE 3.—(Allan Sturge and Mr. Godlee, London, 1881.¹²) A lady had suffered from mimic spasm for over five years. The seventh nerve was stretched below the ear. The operation was followed by paralysis which continued two months. After that time the recovery was complete.

CASE 4.—(Eulenberg, Berlin, 1881.¹²) Nerve-stretching was performed in a case of mimic spasm. Paralysis for five months and complete recovery were the results of the operation.

CASE 5.—Dr. Putnam (Boston, Massachusetts, 1881¹²) reports one case of mimic spasm in which nerve-stretching was performed and recovery followed.

2.—SPASMS IN THE TERRITORY OF THE ACCESSORY NERVE OF WILLIS; THAT IS, SPASMODIC TORTICOLLIS.

Six cases of nerve-stretching in this disease are recorded, only one of which was cured by the nerve-stretching alone. In one case nerve-stretching gave only partial relief, and in two cases it was of no effect. In one of these latter cases the relief was subsequently obtained by excision. In two cases nerve-stretching combined with excision resulted in cure. In one of the last-named cases a return of the spasms occurred for about fifteen minutes, and in the other slight spasms of about one month's duration followed the operation. The disease had persisted from six to eighteen months. The incision was made and the nerve stretched, in each case, at the upper part of the posterior border of the sterno-cleido-mastoid muscle.

From the following cases we conclude that nerve-stretching in this disease is not so efficacious as in mimic spasm, and it seems to be advisable to combine nerve-stretching with excision, as was done in the two cases reported by Hansen.

CASE 1.—(Tage Hansen, Denmark, 1878.²⁵) A woman, thirty-one years of age, had suffered for six months from spasmodic torticollis. The nerve was cut down upon at the upper part of the posterior border of the sterno-cleido-mastoid muscle, and vigorously stretched, and a piece of the nerve, twelve millimetres in length, excised. When the patient awoke from the narcosis, the spasms returned for a quarter of an hour, then ceased, and have not returned.

CASE 2.—(Tage Hansen, Denmark, 1878.²⁵) A woman, thirty years of age, had suffered for one and a half years from spasmodic torticollis. Nerve-stretching was resorted to, and fifteen millimetres in length excised. Slight spasms continued for a month. After this time the recovery was complete.

CASE 3.—(Annandale, 1879.²⁶) A girl, twenty-four years of age, suffered from torticollis, the head being drawn to the left so as to look over the shoulder. When an attempt was made to turn the head to its normal position severe clonic spasms set in. The spinal accessory nerves of the left side were stretched. This operation gave no relief. The nerves were then divided, and immediate relief followed. One year after the operation the mobility was normal and the patient suffered no pain.

CASES 4 and 5.—D. E. Morgan (1879²⁶) reports two cases of spasmodic torticollis, one of which was cured by nerve-stretching. In the other no effect was produced.

CASE 6.—Küster (Berlin, 1880⁷) reports a case of clonic spasms in the muscles supplied by the spinal accessory nerve. The nerve was stretched, but the operation gave only partial relief.

3.—SPASTIC CONTRACTIONS OF THE NERVES OF THE EXTREMITIES.

To the three cases of this disease here recorded might be added the case of Dr. E. Andrews, of Chicago, already mentioned. The case is remarkable as being the only one

in which not only the spasms but also the contracture ceased, and complete cure was effected. Improvement was produced by nerve-stretching in the other three cases: in two of them the tonic spasms diminished, and in the third the spastic cramps ceased, but the contracture remained.

CASE 1.—(Von Nussbaum, Munich, June 23, 1872.⁴) Spastic contraction of the left pectoralis major and minor, flexors of the left arm, forearm, and hand, subsequent to bullet wounds of the elbow and neck. Nerve-stretching was performed, the following nerves being included in the operation: the ulnar nerve at the border of the biceps, the nerve-trunks around the axillary artery, and the inferior cervical nerves in the outer part of the supraclavicular region. The patient's condition was greatly ameliorated by the operation.

CASE 2.—(Von Nussbaum, Munich, 1876.⁴) Tonic spasms in the lower extremity, of eleven years' duration, in a case of paraplegia, subsequent to an injury in the sacral region. The sciatic and crural nerves of one side were stretched, and two weeks later the same nerves of the other side. The patient's condition was much improved by the operation; so much so that he was able to walk with the aid of crutches.

CASE 3.—(Czerny, 1879.¹¹) A student had suffered from birth from hemiplegic contracture with spastic cramps in the right arm, supposed to have been caused by pressure from the forceps during delivery. The axillary plexus was stretched in the axilla, and, later, the supraclavicular plexus. The painful spasms ceased, but the contracture remained.

III.—EPILEPSY.

It is hardly necessary to state that it is only in those cases of epilepsy with an aura from the territory of a peripheral nerve that nerve-stretching can be of use. We have found records of only three cases, with recovery in one, alleviation of the paroxysms in one, and no effect in the other.

CASE 1.—(Von Nussbaum, Munich, 1875.⁴) Reflex epilepsy from leg. The tibial and peroneal nerves were stretched. Perfect recovery.

CASE 2.—(Czerny, 1879.¹²) Epilepsy with aura from ulnar nerve. No decided effect was noticeable. Bromide of potassium was now given, which gave relief.

CASE 3.—(Gillette, Paris, 1881.²⁸) Congenital epilepsy. The median and cubital nerves were stretched at the upper third of the arm. About ninety paroxysms had occurred during the month prior to the operation. In the month succeeding the nerve-stretching only eighteen spasms occurred. The paroxysms diminished not only in frequency, but also in intensity and duration. The greater part of the attacks were merely vertiginous, continuing from two to five minutes. The aura completely disappeared. The wound healed by first intention. The patient experienced a little numbness in the area of the cubital nerve, which disappeared a week after the operation.

IV.—PARALYSIS.

CASE 1.—(Von Mural, 1880.²⁷) A boy suffered from paralysis of the extensor muscles of the arm, subsequent to a fracture of the humerus which had healed in a bad position. The radial nerve was stretched, and complete recovery from the paralysis followed.

V.—TETANUS.

Of twenty-one cases of traumatic tetanus treated by nerve-stretching, nine recoveries and twelve deaths are reported. It would be a great mistake, however, to conclude that the death-rate in traumatic tetanus had been so diminished by nerve-stretching as to reduce it from the usual eighty or ninety to about forty per cent. The reason for this apparent decrease is that all the successful cases have, of course, been reported, but a number of the unsuccessful ones have not. In the discussion on nerve-stretching at the Congress of German Surgeons in Berlin, in 1880, Schede, Hahn, and Sonnenberg stated that they had performed nerve-stretching in tetanus with no effect.⁷ How many unsuccessful cases this statement is intended to include, we do not know.

The nerves stretched were always the nerves of the ex-

tremities. It is difficult to state the exact value of the operation in those cases which recovered, as presumably in all cases some medicine had, in addition, been given. This question will probably never be solved, because no physician would be justified in risking the life of his patient in this terrible disease, by omitting any of the therapeutic remedies at his disposal. We do not, however, consider it just, as some others have done and will do, to deny that nerve-stretching has had any success at all in tetanus, and we think that Morris is not exactly right in his opinion, that the cases in which nerve-stretching has proved successful consist only of those subacute and mild cases of traumatic tetanus in which internal treatment alone would have effected a cure.

First, as to the absolute denial that nerve-stretching has been productive of any good results. It will be seen from the cases recorded, that in severe and even in finally fatal cases there has been a marked, although only temporary effect: namely, the paroxysms have ceased, and the patient has experienced relief for from twelve hours to three days before a fatal relapse set in.

Second, as to Morris' statement that only the subacute and mild cases have been cured by nerve-stretching. We agree with him to this extent, that none of the cases in which recovery has taken place have been cases of *tetanus acutissima*. But when the question of severity is brought up, it is our opinion that the case reported by D'Ollier, which was attended with opisthotonos, difficulty in swallowing, and tetanic contractions of the muscles of the abdomen and lower extremities, can certainly not be counted among the mild forms of the disease.

Further, as to the danger from traumatic tetanus, the statistics of Taylor from Guy's Hospital²⁹ have shown the following connection between the interval from the receipt

of the injury and the first symptoms of tetanus, and the death-rate :

In the cases in which tetanus set in within one week after the receipt of the injury, the death-rate was 87.5 per cent.; when the interval was from one to two weeks, the death-rate was 88 per cent.; and with an interval of from two to three weeks, the rate of mortality decreased to 57.2 per cent. Consequently, we see that those cases in which the tetanus appeared within two weeks after the receipt of the injury are the more dangerous.

Amongst the cases of recovery after nerve-stretching we find one interval of seventeen days, one of fourteen, one of eight, one of seven, and one of four. Three of these cases, therefore, as far as the importance of the intervals goes, belonged to the dangerous class of cases.

We willingly admit that the amount of material at our disposal does not enable us to form a decided opinion about the value of the operation as a curative method in tetanus, but we consider it as unquestionably proved that some beneficial effect has been derived from nerve-stretching in this disease.

It seems to us, as a natural and necessary consequence of this, that the operation is imperative in each and every case in which there is any possibility of getting at the nerve-trunks, through which the primary impulse of this terrible disease is conveyed to the central nervous system ; and this so much the more as nerve-stretching is an innocent and non-mutilating surgical procedure compared with, for instance, amputation, which has been so often tried in vain that it has been abandoned, not because of the loss of the limb, which would be submitted to gladly, but because of its utter want of efficacy in checking the progress of the disease.

A question as yet entirely open is this: Would not

division or section of the nerves be more successful in certain cases than nerve-stretching? Morris expresses this opinion. In one of our own cases where the axillary plexus above the clavicle had been stretched with no effect, a subsequent division of these nerves caused the very violent and frequent tetanic spasms to cease for twenty-four hours in a severe and finally fatal case of tetanus.

It seems to us that it would be worth while, in these cases, either to combine division of the nerves with the nerve-stretching, or to perform division when nerve-stretching has been performed in vain. Nothing is lost in following either of these two plans; as, first, the ends of the divided nerve will grow together again in a few weeks; and, second, reopening of the wound under antiseptic precautions will not be prejudicial to the healing of the wound by first intention.

CASE 1.—(Paul Vogt, 1876.³⁰) A laborer, 63 years old, two weeks after receiving a wound in the palm of the right hand, which had healed, was seized with trismus, severe opisthotonos, and severe clonic convulsions. There was no tenderness in the cicatrices nor along the course of the nerves in the arm and forearm, but pain was experienced on pressure on the brachial plexus and neck. The brachial plexus of the right side was stretched above the clavicle. The cicatrices in the hand were also excised. Immediate relief of the symptoms was experienced, and recovery followed. Opium was the only medicine employed.

CASES 2, 3, and 4.—Vogt (1876⁴) reports three cases of nerve-stretching in tetanus, two of which were perfectly successful. In the third case the patient died.

CASE 5.—Verneuil (1876³²) reports a case of stretching of the ulnar and median nerves in tetanus with recovery.

CASE 6.—(Drake, 1876.^{31, 32}) A man, 28 years of age, was seized with severe tetanus from a slight injury of the left foot. The sciatic nerve was stretched and calabar bean administered. The convulsions ceased for about twelve hours, then recurred in a mild form for three days, after which time they increased in severity, and the patient died on the twelfth day after the operation.

CASE 7.—(Ransohoff, Cincinnati, 1879.³²) A boy, 13 years of

age, wounded the left foot by stepping upon a piece of rusty iron. The wound healed quickly. Eight days after the injury, trismus and tetanus set in. The cicatrix was excised, and hydrate of chloral and calabar bean administered, but without effect.

On the fourth day after the tetanus set in, an incision was made behind the internal malleolus, and the posterior tibial nerve stretched. The convulsions in the injured limb ceased immediately after the operation. There was a gradual decrease in the severity of the symptoms, and in three weeks the recovery was complete.

CASE 8.—(Hutchinson, London, 1879.³³) Injury to right leg by a wound from a shot-gun, followed by a high degree of acute tetanus. The right sciatic nerve was stretched with considerable force. After the operation the patient passed a quiet night. The next morning a relapse occurred, and twenty hours afterward the patient died during a convulsion.

CASE 9.—(Morris, London, 1879.³⁴) Ten days after a superficial injury of the right foot, in a boy 7 years of age, severe tetanus set in. The sciatic nerve was stretched. A severe convulsion occurred immediately after awaking from the narcosis, and the patient died six hours later.

CASE 10.—(H. G. Clark, 1879.³⁵) A female, 24 years of age, suffered disarticulation of the right hallux by a street-car accident. Seven days later, trismus, tetanus, and tenderness along the course of the anterior tibial nerve occurred. Four days later the right sciatic nerve was stretched. Immediately after awaking from the narcosis a convulsion occurred. Calabar bean was administered. The spasms ceased for twenty-four hours. The patient then relapsed. Calabar bean and morphine were given, and ice applied along the vertebral column. The patient recovered in six weeks. In the author's opinion, the course of the disease was not influenced by the operation.

CASE 11.—(Dr. Fenger, Chicago, 1880.)

SYNOPSIS.—*Crushing injury to the left forearm. Amputation at lower third of humerus. Tetanus after thirty-six hours. Stretching of axillary plexus above the clavicle. Little or no effect. Forty-eight hours later, reopening of wound and division of nerves of brachial plexus. Paroxysms of pain and opisthotonos entirely stopped for thirty-six hours. Relapse, and death after two days.*

I. B., a German laborer, fifty-five years of age, was brought to Cook County Hospital, Aug. 3, 1880, and placed in the care of Dr. Fenger. A few hours before, the left hand had been torn

completely off in a machine ; the ulna and radius were broken at about the middle ; to the hand was attached the skin of the forearm almost up to the elbow joint ; the tendons and muscles of the forearm were irregularly torn. This injury necessitated immediate amputation at the lower third of the humerus.

August 4th. The patient rested well during the night ; temperature and pulse normal. Some vomiting followed the administration of ether.

August 5th. Late last night paroxysms of pain in the amputation-wound set in, which were followed by trismus, contraction of the posterior muscles of the neck, opisthotonos. Sleep disturbed by the paroxysms. The patient can open his mouth only about half an inch. The posterior muscles of the neck are moderately stiff. He does not complain of any pain, except at the time of the paroxysms, which occur about every two hours and conclude in twitchings, that is, painful contractions of the muscles of the stump. As the disease was manifestly tetanus, and each paroxysm appeared to have its starting-point in the nerves of the amputated arm, Dr. Fenger resolved to try nerve-stretching of the brachial plexus.

The patient was anæsthetized. An incision six centimetres in length was made in the supraclavicular fossa, half an inch above, and parallel with, the upper border of the clavicle. The *platysma* was divided upon the guide, but after this the dissecting forceps alone was used in separating the tissues to reach the brachial plexus. The large nerve-trunks were drawn out of the wound separately by means of the blunt hook, stretched by traction both in the central and peripheral ends. These thick nerve-trunks were, furthermore, compressed between the thumb and index finger. They were then slipped into the wound; a drainage tube inserted ; the wound closed and dressed antiseptically.

August 6th. Yesterday afternoon the paroxysms were fewer in number and less violent. The patient slept some during the night. He says that he feels better than before the operation, but on examination it was found that the lockjaw and stiffness of the muscles of the neck were the same as the day before. Calabar bean, morphia, and chloral were administered.

August 7th. The patient slept very little during the night on account of spasms in the arm and paroxysms of opisthotonos, which rapidly increased in violence and frequency, occurring every fifteen minutes. The patient looked haggard and anxious.

As the tetanus was evidently progressing toward a fatal ter-

mination, Dr. Fenger resolved to divide the nerves in the brachial plexus, thinking that as the paroxysms had their initial point in the nerves of the stump, division of the nerves might control them.

The patient was again anæsthetized. The wound, when reopened, was seen to be agglutinated by perfectly healthy-looking, coagulated plasma. The large nerve-trunks of the brachial plexus were easily found, taken out of the wound, divided with scissors, and then replaced, and the wound was closed and dressed antiseptically.

August 8th. The paroxysms of pain in the stump, and the opisthotonos have entirely ceased since the operation. The patient slept well during the night, feels much relieved, and talks hopefully. The muscles of the neck are less stiff, but the patient is still unable to open his mouth more than about half an inch. The internal treatment was continued. The amputation-wound was dressed, and no swelling nor suppuration found.

August 9th. The patient had a return of the paroxysms of opisthotonos last night, until they recurred with their former frequency. The convulsions increased during the night, so that they occurred every five minutes. The trismus is unchanged. The patient still takes a good deal of nourishment.

August 10th. Pulse, 130; temperature, 102.75°. The paroxysms are increasing in violence and frequency. They occur now every two or three minutes.

August 11th. Last evening the patient became delirious. After this the paroxysms stopped. Toward morning the breathing became difficult, the pulse weaker, and he died a little before nine o'clock this morning.

CASE 12.—(Dr. Fenger, Chicago, 1880.)

SYNOPSIS.—*Crushing injury to left elbow joint. Tetanus five days later. Amputation at the middle of the humerus, with vigorous stretching of all nerves in the amputation-wound. No effect on the tetanus. Twelve hours after the operation, death.*

Joe Chastrand, a painter, 29 years of age, entered Cook County Hospital, July 6, 1880, and was placed in my care. About nine o'clock in the morning, while painting at a distance of 55 feet from the ground, one of the hooks holding the flying-stage gave way and precipitated the patient to the roof, 40 feet below. He struck on the head and left side, producing an incised wound, about two inches and a half in length, on the left side of the forehead; dislocation of the left elbow; fracture of the right radius

about one inch and a half above the wrist, the fragments having at this point ruptured the skin, making a wound about an inch in length; fracture of right half of pelvis. The dislocation was reduced previous to his admission to the hospital.

On admission, four hours after the accident, the patient did not show any evidences of shock, talked well, and suffered but little pain.

The wound communicating with the formerly dislocated elbow joint was carefully cleansed, a drainage tube inserted, and antiseptic dressings applied. The arm was placed in a rectangular suspension-splint; the other wounds were also dressed antiseptically.

July 7th. Slept some during the night. No fever. The wound at the elbow was dressed.

July 12th. Last night tetanus set in. The arm was amputated at the middle of the humerus, and during the operation the nerves were stretched in the amputation-wound.

July 13th. The stretching of the nerves yesterday had no influence at all upon the tetanus, the paroxysms of which increased during the afternoon and night. In the night the patient became delirious, and died this morning.

CASE 13.—(Dr. Fenger, Chicago, 1880.)

SYNOPSIS.—*Punctured wound of the right hand. Four days after the injury, trismus and opisthotonos. Fourteen days after the injury, stretching of medianus ulnaris, and cutaneous internus longus nerves in the sulcus bicipitis. Immediate relief of the symptoms. Trismus and tetanus entirely disappeared after four days. Parèsis in the territory of the medianus and ulnaris nerves for seven months. Neuralgic pains along the trunks of the nerves stretched, and hyperæsthesia on the dorsal side of the third and fourth fingers for three weeks. Recovery.*

W. H. O'Connor, a carpenter, 43 years of age, entered the hospital July 10, 1880. On June 26th he ran a rusty ten-penny nail into the palm of the right hand, half an inch anterior to the pisiform bone. The nail projected from a board about four inches, and the wound was made by striking the hand against it. When he pulled the nail out, the blood spurted in a continuous stream, and he lost about half a pint. He had a stream of cold water running upon the wound the whole night to "get the rust out," and afterward put goose-oil on it.

Four days later, he experienced pain and swelling in the palm of the hand, and the fingers became stiff. He sought medical aid

at the Central Free Dispensary, and was there directed to use poultices of flaxseed meal and bread-and-milk on the wound.

The pain radiated upward from the hand to the mouth and then to the neck. The trismus was so painful that he pounded himself on the sides of the jaw to produce relaxation of the contracted muscles, but without effect. The night before he entered the hospital, he had two men pound and squeeze the muscles of the neck and jaw, and forcibly open the mouth, but in vain. The pain and swelling of the hand subsided after three or four days, but the trismus and opisthotonos increased to such an extent that he became afraid they would choke him, and for this reason came to the hospital.

On admission, he was found to be a well-nourished, robust-looking man. In the posterior part of the thenar of the fifth finger of the right hand was a small cicatrix from the punctured wound which had healed, with no swelling around it, but tender to the touch. The pain radiated upward along the inner aspect of the forearm and arm. The jaws could not be separated more than one-sixth of an inch, and the posterior muscles of the neck were so stiff that the head could not be moved. He was ordered calabar bean, hydrate of chloral, and bromide of potassium.

July 11th. As the trismus and opisthotonos were the same as on the preceding day, nerve-stretching was resorted to. An incision, two inches and a half in length, was made in the middle third of the arm, over the *sulcus bicipitis*. The internal cutaneous, median, and ulnar nerves were taken out of the wound, stretched vigorously in both directions, pressed between the fingers and an elevator of the palpebræ with which they were taken from the wound, and then re-inserted in the wound. No drainage tube was inserted. The wound was closed with antiseptic silk, and Lister dressing applied.

July 12th. Pulse, 64; temperature, 99.5°. Last night, eight hours after the operation, he was able to open the mouth a little more, so as to allow the tongue to pass out. The stiffness of the neck continued the same. He slept well during the night, and to-day, twenty-four hours after the operation, he feels better, and is able to open the mouth sufficiently to admit two fingers. The neck is much less stiff than it was last night, and he can move the head a little. The internal medication was continued.

July 13th. The patient slept well and feels much better. He can now open the mouth freely and move the neck, but the latter is still a little stiff and somewhat painful when moved. The third,

fourth, and fifth fingers are painful, and so far paralytic that he can flex them but very little, but is able to extend them. Paresis of the ulnar and median nerves is also present.

July 14th. There is still a little pain in the nape of the neck ; no stiffness in the jaws. There is still pain in the third, fourth, and fifth fingers. The patient slept well all night.

July 15th. The patient complains of pain along the course of the nerves which were stretched, considerable enough to render five hypodermic injections of morphia necessary during the day. No stiffness in the jaw or neck. Discontinued the calabar bean, hydrate of chloral, and bromide of potassium.

July 16th. The patient feels numbness on the flexor side of the forearm. He can move the thumb slightly, but can only slightly flex the fingers. There is occasionally stinging pain on the dorsal surface of the hand, and shooting pains in the fingers. Pulse, 62 ; temperature, 98.5°.

July 18th. He complains of twitchings in the fingers, particularly the middle and ring fingers, which are very sore along the dorsal surface. There is no pain along the inside of the arm, but he complains of pain in the shoulder ; is up and around the whole day ; sleeps well ; and his appetite is good. The interrupted current was ordered to be applied once a day to the arm and hand.

August 7th. The patient can move the fingers better, though flexion is not yet normal. He still occasionally complains of pain in the palm of the hand and the middle and ring fingers.

The patient was discharged to the County Poor-house, cured.

March 1, 1881. Anæsthesia and paresis of the forearm commenced to disappear rapidly.

April 15th. There is no atrophy of the forearm, no anæsthesia or pain ; there is a little stiffness of the fingers, but active mobility is normal, so that he can flex the fingers until the ends of the fingers touch the palm of the hand. Sensibility of the fingers is normal, but they are a little colder than the fingers of the hand not operated upon.*

CASE 14.—(Pepper, London, 1881.³⁶) A railway signalman received a crushing injury of the hand, with a lacerated wound. Three fingers were torn off. Antiseptic dressing was applied, and the wound healed rapidly. Two weeks after the injury was received tetanus set in. The median and radial nerves were

* As a remarkable feature, we here mention that, after the anæsthesia and paresis of the nerves stretched had persisted for seven months, in spite of all kinds of treatment, they disappeared spontaneously in the course of two weeks.

stretched. The paroxysms were relieved for two days, but on the third day after the operation the spasms recurred violently, and the patient sank and died.

CASE 15.—(H. D'Ollier, Paris, 1881.³⁷) A man, 54 years of age, received the following injuries from a tree falling upon him: flesh wound on right forearm; large, lacerated wound on the extensor side of the left forearm, whereby the extensor tendons were denuded; subcutaneous fracture of the left femur. A diffuse, phlegmonous inflammation took place, on the third day after the accident, in the right forearm, which was subdued by large multiple incisions. On the tenth day, at a period when the condition of the wounds was very favorable for speedy healing, painful spasms of the flexor muscles of the forearm set in, causing the fingers to be very firmly flexed. These paroxysms increased in number and violence for a week, and then symptoms of tetanus commenced; lockjaw; stiffness of the neck; difficulty in swallowing; and tetanic contractions of the muscles of the abdomen and lower extremities. The patient was anæsthetized, the median nerve laid bare in the middle of the arm, and stretched vigorously in both directions. After the operation the pain and muscular spasms ceased, and extension of the fingers could be more easily accomplished. Recovery.

CASES 16, 17, 18, 19, 20, and 21.—(1879.³⁸) Nankewell reports two cases of traumatic tetanus, in which no effect followed nerve-stretching. Langton, Verneuil, and Cowper each report an unsuccessful case of nerve-stretching in tetanus, and Ratton places on record a case of tetanus, treated by nerve-stretching, which was followed by recovery.

VI.—LOCOMOTOR ATAXIA.

It was the excruciating and distressing pain, which, at a certain period of this disease, embitters the existence of the patient, that furnished the indication to Langenbuch to try nerve-stretching. The unexpected effect of the operation, namely, that not only the pain was relieved, but also that the symptoms of incoördination disappeared, attracted well-merited attention, as all the remedies hitherto employed in this disease had been devoid of practical value and, in fact, had appeared to exert no influence whatever upon the course of the disease.

The seven cases which are reported below are of too recent date to enable us to determine whether or not the beneficial effects of the operation were lasting or finally curative. But, nevertheless, the operation has manifestly been of benefit in two very important directions: First, as to the pain. The records show that it has been relieved, or rather has entirely disappeared in the five cases in which pain was noted among the symptoms. Second, as to the ataxic symptoms, especially incoördination, loss of muscular power in the limbs affected, and consequent inability to walk or stand. These symptoms entirely disappeared in two cases, were markedly diminished in two cases, and partially diminished in one case in which the muscular strength increased. In one case the effect may have been experienced, but is not recorded, and in one case only was the operation of no effect as regards these symptoms.

The nerves stretched were both sciatic and crural nerves in one case; both sciatic nerves in three cases; the left sciatic nerve in one case; the axillary nerves in one case; and the right median and ulnar nerves in one case.

It may be that the two cases in which the ataxic symptoms entirely disappeared were cases of only short duration, as in Langenbuch's case, in which the patient died accidentally during the chloroform narcosis for the second operation upon the upper extremity, the autopsy showed no anatomical lesion in the posterior columns of the spinal medulla.

But that even inveterate cases may be effectually acted upon by the operation is shown by Debove's first case, in which, although the disease was of six years' standing, and the patient had been confined to his bed for eighteen months previous to the operation, the pain not only disappeared, but the severe ataxic symptoms also diminished so considerably as to allow the patient to stand erect and walk a few steps in two weeks after the operation.

In our own case no effect upon the ataxic symptoms was experienced. It is possible, however, that the complication with large bedsores, and the subsequent low condition of the patient, masked a beneficial effect which might otherwise have been apparent. On the other hand, the most characteristic symptom, namely the incoördination, may not be affected at all, as may be seen in Erlenmeyer's case.

As to what and how many nerve-trunks it is advisable to operate upon in a case of locomotor ataxia, we shall take into consideration the following facts: The very interesting and unexpected crossed and distant effect of the nerve-stretching, which was first seen as an exception in Andrews' case of painful contractures of the lower extremities, but which has now been fully confirmed, as a rule, in locomotor ataxia, and which has been further confirmed by Brown-Séquard's experiments, leaves it an open question whether it might not be sufficient to operate upon only a limited number of the nerves of the extremities affected. When Esmarch stretched the axillary nerves for pain in the upper extremities, the ataxic symptoms of the lower extremities ceased. When Debove stretched the right median and radial nerves, the pain disappeared in the opposite arm, and diminished in the arm operated upon. This crossed and distant effect is by no means constant. It has been noted in none of the other cases, and we have as yet no means of determining beforehand in what cases such an effect will take place, and in what cases it will not.

It, therefore, seems at present to be the most natural plan to take the indications for the place of operation from the pain, and to commence to stretch the nerve-trunks in the territory in which the most severe pain is suffered. From the effects of this first operation, indications for the

stretching of other nerve-trunks may be determined. As the inconveniences subsequent to the operation are very few and insignificant, and as the course of the disease is sufficiently chronic as not to render any rapid surgical interference imperative, it seems to us that no contra-indication exists for this plan of experimental operating by degrees.

CASE I.—(Langenbuch, Berlin, 1879^{40, 41}; Westphal, Berlin, 1881.⁴²) A merchant, 40 years of age, had been several months before attacked with symptoms of *tabes dorsalis*. When he entered the hospital the symptoms were so pronounced that there was no doubt that the disease was *tabes dorsalis dolorosa*. Besides thoroughly developed ataxia, there were peculiarly intense shooting pains in all four extremities. Romberg's symptom was present, and the typical disturbances of sensibility, especially in the lower extremities. In walking, the patient threw off his slippers without being aware of it, and was unable to distinguish what he was walking on. From time to time, constriction, as of a belt, was felt. The reflex sensibility was somewhat augmented. The knee symptom was not present, but a high degree of myosis, and hyperæsthesia of the skin were observed, especially on the anterior surface of the femur. All these disturbances of innervation were also present, though in a less degree, in the upper extremities. The patient was tortured by incessant pain, in spite of all sedative treatment.

As the pain was most intense in the region of the left sciatic nerve, Dr. Langenbuch proposed to stretch it. With the patient's consent the operation was performed September 13, 1879. The trunk of the sciatic nerve appeared somewhat reddish, injected, and swollen. Under anæsthesia, it was thoroughly stretched, and sutures and antiseptic bandages applied. The wound healed in a few days, the patient having experienced entire absence of pain from the moment of the operation. The immediate consequence of the stretching was motor and sensory paralysis, which disappeared in a few days without any return of the pain.

Twelve days after the first operation, Dr. Langenbuch was able to proceed to the stretching of the right sciatic and both of the crural nerves, in one operation. Under antiseptic treatment the wounds healed in a short time. This operation was followed by the same results as the former; the pain disappeared perma-

nently, and the normal mobility and sensibility were regained in the course of a few days.

When the patient made his first essay at walking, he expressed himself that he now at least knew what he had beneath his feet. The first attempts at walking were feeble and incomplete, but improved rapidly. The unexpected fact was soon discovered that the ataxic symptoms had disappeared at the same time. When the patient had so far recovered that he was able to walk moderately well, he left the hospital.

Later he entered another hospital, when it was found on examination that the ataxic symptoms had entirely disappeared, and that there was no diminution of sensibility in the lower extremities. The patient was able to walk with the aid of a cane, and complained only of the above-named symptoms in the upper extremities.

As the pains in the upper extremity were increasing, and as the result of the operations on the lower extremities had been so unexpectedly favorable, it was resolved to stretch the nerves of the upper extremity, but the patient died unexpectedly during the chloroform narcosis. The autopsy, made by Dr. C. Westphal, demonstrated conclusively that in this case there was no disease in the posterior columns of the spinal cord.

CASE 2.—(Esmarch, Kiel, 1880. ⁴³) A brief notice was made, in the Ninth Congress of German Surgeons, held in Berlin in 1880, of a case which Quinke had diagnosed as *tabes dorsalis*, in which violent pains in the upper extremity were experienced. The nerves in the axilla were stretched. The operation was followed by very satisfactory results: not only the pain in the upper extremities, but also the pain in the lower extremities, as well as the other symptoms of ataxia ceased.

CASE 3.—(Erlenmeyer, 1880. ⁴⁴) A man, thirty-nine years of age, suffered from so-called "rheumatic" pains in the right leg, in 1871, which continued increasing slowly until 1878, when manifest symptoms of ataxia were noticed. In December, 1878, paresis of the bladder occurred. In the summer of 1879 the patient became unable to walk or stand. In November, 1879, exquisite ataxia of the lower extremities set in, with a very considerable lack of coördination. The extremities were cold; sensibility was diminished; patellar reflex absent; the patient could not feel the position of his legs at all. He had very little "druckkraft" (pressure-force). Most of the time there was no pain at all in the legs. Incontinence of urine was present.

Diagnosis, *tubes lumbalis* ; prognosis, unfavorable. All other known remedies having been tried in vain, nerve-stretching was resorted to.

June 22, 1880, the patient was anæsthetized with chloroform, an incision made between the great trochanter and the *tuber ischiæ*, and the right sciatic nerve exposed. It was lifted from the wound, stretched vigorously, and twisted. The nerve was flattened and of a grayish color.

July 3d. The ataxia, sensibility, and tendon reflex were exactly the same as before the operation, but the "druckkraft" was considerably augmented, as might be seen by comparing the right leg which had been operated upon, with the left leg which had not. The patient was still unable to stand up.

At this date the left sciatic nerve was stretched in the same manner as in the former operation, strict antisepsis being maintained in each operation. In spite of the antiseptic precautions, however, erysipelas set in in the wound and continued for three weeks. Examination then showed an augmentation of the "druckkraft," but no amelioration whatever of the other ataxic symptoms.

CASE 4.—(Debove, Paris, 1880. 45) A man, fifty-six years of age, was seized, in 1874, with vehement pains in both legs, and six weeks later symptoms of incoördination appeared. This was followed by pains in the upper extremities, but no incoördination was here noticeable.

November, 1880, the patient entered the hospital. He complained of attacks of severe pain in the lower extremities, which increased in violence at night. Subcutaneous injections of morphine were ordered, and as much as three grains was given in the course of twenty-four hours. Every one or two weeks attacks of gastric, urethral, and vesical pain were experienced. Slight cystitis also existed. Incoördination was present only in the lower extremities, which were highly atrophic. The patient had been obliged to remain in bed for the previous eighteen months. There were bedsores on his back.

November 18th. An incision was made in the middle of the thigh, the left sciatic nerve retracted, and stretched vigorously in both directions. The nerve was replaced, the wound closed, and antiseptic dressing applied. From the day after the operation no pain was felt in any of the extremities, and only slight pain in the wound. Formication, from time to time, commenced in the left leg, and from there extended to the right leg. Two days later

there was no pain whatever. He could feel his legs in the bed. The incoördination in both extremities had diminished. Two weeks after the operation no return of the pain had been experienced. The sensibility in the lower extremities was normal. He could move the legs so much better that only traces of the incoördination remained. The patient could now stand erect and take a few steps with the support of another person. The wound did not heal by first intention. The gastric trouble disappeared.

CASE 5.—(Debove, Paris 1880.⁴⁶) On December 16, 1880, a case of locomotor ataxia was operated upon, in which the constant severe pains with exacerbations were mainly confined to the upper extremities. The right median and radial nerves were stretched. After the operation the pain diminished in the right arm and disappeared entirely in the left arm; and in the lower extremities the plantar anæsthesia diminished considerably on the left side. The incoördination was so much ameliorated that the patient was able to walk without help. He is now able to sleep regularly.

CASE 6.—(Fenger, Chicago, 1880.⁴⁷)

SYNOPSIS.—*Locomotor ataxia of two years' duration. Incoördination of muscles of lower and upper extremities. Oculo-motor paresis with diplopia. Fulgurant paroxysmal pains in lower extremities. Stretching of both sciatic and crural nerves. Healing of wounds by first intention. Cessation of paroxysms of pain. No change in the rest of the ataxic symptoms. Bedsores. Pyæmia. Death.*

Charles Grundin, a cabinet-maker, fifty-four years of age, was admitted to Cook County Hospital, September 6, 1880. The patient states that his family history is good. His parents died of old age. No hereditary tendencies; no venereal disease. He has used stimulants moderately. Habits and surroundings good. Has had several attacks of intermittent fever of short duration; once suffered from slight dysentery, and once from acute rheumatism. These diseases all occurred twenty years ago. Since that time his health has been uniformly good until two years ago, when he had an attack of incoördination and numbness of the lower extremities, slight strabismus and ptosis of the left eye. These symptoms were relieved by medicinal treatment in six weeks. Since this time, excepting a slight numbness of the feet and fingers, he has been perfectly well, until four weeks before he entered the hospital, when he began to have difficulty in walking, particularly in the dark. He lost considerable strength in the

lower extremities, and the pain in the feet and the ends of the fingers increased.

On admission the patient said that, generally speaking, he felt pretty well; his appetite was excellent, bowels regular, and he slept well.

On examination we found a marked loss of coördination in the lower extremities; he was unable to stand erect when his eyes were closed or when he looked upward. There was a marked diminution of cutaneous and muscular sensibility, the patient being unable to perceive the contact of his feet with the floor, the feet seeming to rest on sand. There was paresis of the *motor oculi* nerve, which was noticeable on account of the diplopia. The patient stated that he had noticed a diminution of his visual powers, especially in the right eye. He complained of occasional difficulty in micturition, it being more frequent and requiring considerable effort. His hands and arms were tremulous, so that he was unable to hold any object steadily. He did not seem to be annoyed by any undue irritation regarding his sexual desire, although he stated that previous to the present illness he had been addicted to excessive indulgence in sexual luxuries. Examination of the vital organs revealed nothing of note.

September 14th. Was given fluid extract of ergot, and iodide of potassium. The patient complains of fulgurant pains in the left thigh and leg, which recur several times daily.

October 8th. Feels as though his legs were asleep.

October 14th. He can obtain rest and sleep only by means of morphine.

November 6th. The patient has been unable to walk for the last three weeks, and has been confined to his bed. Suffers pain in both lower extremities. Sleep can only be obtained by the use of morphine. His appetite is poor and he is getting weaker.

December 28th. The patient was anæsthetized with ether, and Dr. Fenger proceeded to stretch the nerves of the lower extremity. An incision was made on each side, just below Poupart's ligament, the crural nerves exposed, stretched, replaced in the wounds, drainage tubes inserted, the wounds closed with aseptic silk, and Lister dressing applied. The patient was then turned on his face and both sciatic nerves stretched simultaneously, the left by Dr. Fenger and the right by Dr. Verity. Drainage tubes were inserted, the wounds closed with aseptic silk, and Lister dressing applied.

December 29th. Temperature, 101°. Some pain in the right

thigh and leg, which was controlled by a hypodermic injection of one-fourth grain of morphine.

December 30th. Pulse, 112; temperature, 99°. The patient has less pain.

January 3, 1881. The wounds were dressed. They looked well and were agglutinated. No suppuration. The sutures and drainage tubes were removed. He does not complain of any pain.

January 10th. The wounds are entirely healed, and the Lister dressing was removed.

January 20th. The patient's appetite is poor; strength gradually failing. He is not able to stand up. There is no increase of strength in the legs, but he does not complain of pain in the extremities any longer.

February 1st. A bed sore was found over the sacrum. The patient feels weak, has no appetite, but no pain.

February 10th. Pulse, 110; temperature, 103°. The bed sore is considerably enlarged and suppurating. The patient is slightly delirious.

February 15th. The patient died this morning on account of pyæmia from the extensive bed sores.

CASE 7.—(Socin, Basle, 1881.³⁷) A man, 33 years of age, was affected with ataxia, which was characterized by marked troubles of coördination, constricting pain in the body, and violent pain in both lower extremities. The right sciatic nerve was stretched. The wound did not heal by first intention, but, notwithstanding the suppuration, the pain on the right side ceased entirely. The same operation was now performed on the left side. Fourteen days after the second operation was performed, the patient died from multiple embolism, caused by thrombosis in the right popliteal vein.

VII.—ANÆSTHETIC LEPROSY.

CASES 1 and 2.—James R. Wallace (1881⁴⁸) reports, in the *Indian Medical Gazette*, two cases of advanced anæsthetic leprosy, which were both greatly benefited by nerve-stretching. In the first case the disease manifested itself in the arm. After the operation the recovery of sensation was perfect, and the patches of discolored anæsthetic skin recovered their normal color and sensation. The pain, numbness, etc., disappeared, and at the end of two months the improvement seemed confirmed and complete.

From the résumé given above of the different affections of the nervous system in which nerve-stretching has been tried, with the added abstracts of cases, imperfect as it may be, as only a limited portion of the literature has been at our disposal, it will easily be seen that each class of these diseases or affections of portions of the nervous system will have, in future, to be treated of in a separate chapter of its own, as each of these diseases is different, not only as to the indications for the operation, but also as to the prognosis, the effects of the operation, etc.

It is illogical to speak of or discuss indications, effects, and results of nerve-stretching in general, or to talk enthusiastically for or against the operation as such. Von Nussbaum, only two years ago, stated that relapse of the suffering for which nerve-stretching had been performed had not yet been observed, although in some cases four to five years had elapsed since the operation. It will readily be seen that this remark was far too enthusiastic from the present status of our knowledge of the matter. It was only a very short time after this assertion of Von Nussbaum was published, that Czerny made the much less enthusiastic remark, that he would not place any extravagant and exaggerated hopes on the nerve-stretching, but, on the other hand, that he would not deny that the operation was a powerful remedy for the depression of vitality in a nerve-trunk, without its annihilation, and that he would consequently resort to the operation as an *ultimum refugium* in cases in which motor and mixed nerve-trunks had been roused to an abnormal condition of activity from one or another cause. For the sensory nerves he would prefer excision.

Our preceding remarks regarding the necessity of individualization do not permit us to agree with Czerny. This will be seen from several of the facts stated above, namely: A motor nerve, as the seventh, is stretched with perhaps in-

variably good results in mimic spasm. Another principally motor nerve, the twelfth, shows better results by excision than by stretching in spasmodic torticollis. In entirely sensory nerves, as the fifth pair, nerve-stretching has shown somewhat better results than excision, and, finally, the crossed and distant effects from nerve-stretching indicate with sufficient clearness that the benefit of the operation does not depend merely upon the depression of activity in the nerve-trunk stretched, but rather upon its effect upon the nerve-centres, of which we are as yet entirely ignorant.

We should not be surprised if future observers should show that from this effect of nerve-stretching upon the brain and spinal medulla, extensive benefit might be derived from the operation, and give further indications for its advisability in diseases in which it had not previously been tried.

A few remarks only remain before we leave this subject.

The duration of the disease of the nerve does not appear to have any direct influence upon the effect of the operation, as it has sometimes proved successful in most inveterate cases. The condition in which the nerve-trunk stretched has been found, namely: injection, swelling, atrophy, anæmia, or apparent health, has been of equally slight importance as regards the results.

Whether the wound necessitated by the operation has healed by first intention, or after suppuration, or even after complication with erysipelas, it has not affected the final result of the nerve-stretching. The two latter complications, therefore, have done no further harm than the causing of inconvenience to the patient.

As to the question of possible danger attributable to the nerve-stretching, it must be said that, so far as the records go, there has been no danger at all from the stretching of the nerve itself; that is, there has been no neuritis, no tetanus, no permanent paralysis, etc.

As far as the question of danger from the wound is concerned, it may be stated that there is no more and no less danger than from any other incised wound of the same size. It will be almost always in the power of the surgeon to obviate any grave or dangerous complication, by using strictly antiseptic precautions, by being careful of the adjoining organs, by choosing the most appropriate anatomical locality for the operation, etc.

In conclusion, we think that nerve-stretching deserves to have a fair trial, not only in the nervous diseases above referred to, but also experimentally in others, as well of the central as of the peripheral nervous system.

When numerous observations shall be in the future collected, and the cases of homologous affections classified, we shall then have more sharply-defined indications for operation than we have had up to the present time, when neuralgic pains or spasms have, with few exceptions, been the main and only indications for nerve-stretching.

BIBLIOGRAPHY.

1. *Practitioner*, vol. cix, 1877, p. 417.
2. Deahna, Stuttgart, *Schmidt's Jahrbücher*, B. 184, No. 10, 1879, p. 50.
3. *Hospitals-Tidende*, ii R., B. 5, 1878, p. 44.
4. *Chicago Medical Journal and Examiner*, vol. xxxvi, No. 3, 1878, p. 225.
5. *St. Louis Medical and Surgical Journal*, vol. xxxviii, No. 4, 1880, p. 24.
6. *Deutsche Medicinische Wochenschrift*, No. 36, 1880, p. 487.
7. *Deutsche Medicinische Wochenschrift*, No. 19, 1880, p. 258.
8. *Lancet*, vol. i, Feb. 14, 1880, p. 248.
9. *Lancet*, June, 1878, p. 904.
10. *St. Petersburger Medicinische Wochenschrift*, vol. iii, No. 34, 1878, p. 281.
11. *Archiv für Psychiatrie und Nervenheilkunde*, 1879, p. 284.
12. *British Medical Journal; Chicago Medical Journal and Examiner*, March, 1881, p. 313.
13. *British Medical Journal*, June 14, 1879, p. 893.
14. *Schweizerisches Correspondenz-Blatt*, B. ix, No. 11, 1879, p. 324.

15. *British Medical Journal*, May 31, 1879, p. 803.
16. *St. Petersburger Medicinische Wochenschrift*, No. 49, 1879.
17. *Medical Times and Gazette*; *Progrès Médical*, January 22, 1880, p. 66.
18. *Bayerisches, Ärztliches Intelligenz-Blatt*, vol. xxv, No. 53, 1878, p. 558.
19. *Berliner Klinische Wochenschrift*, No. 39, 1880, p. 554.
20. *Lancet*, June 26, 1875.
21. *Schmidt's Jahrbücher*, B. 184, 1879, p. 258.
22. *Deutsche Medicinische Wochenschrift*, No. 5, 1880.
23. *Berliner Klinische Wochenschrift*, 1878, p. 595.
24. *Berliner Klinische Wochenschrift*, No. 46, 1879, p. 184.
25. *Hospitals-Tidende*, ii R., B. 5, 1878, p. 45.
26. *Lancet*, April, 1879, p. 555.
27. *Correspondenz-Blatt für Schweizer Arzt*, Nov. 5, 1880.
28. *Progrès Médical*, February 5, 1881.
29. *Guy's Hospital Reports*, from 1866 to 1877, No. xxiii.
30. *Centralblatt für Chirurgie*, 1876.
31. *Canada Medical and Surgical Journal*, October, 1876.
32. *Cincinnati Lancet and Clinic*, January 18, 1879, p. 41.
33. *Medical Times and Gazette*, June 7, 1879, p. 618.
34. *British Medical Journal*, June 21, 1879, p. 933.
35. *Glasgow Medical Journal*, July, 1879, p. 10.
36. *American Practitioner*, March, 1881, p. 157.
37. *Progrès Médical*, February 26, 1881, p. 166.
38. *Lancet*, December 27, 1879, p. 964.
39. *Gazette des Hôpitaux*; *Chicago Medical Review*, March 20, 1881, p. 125.
40. *Berliner Klinische Wochenschrift*, No. 48, 1879.
41. *Chicago Medical Review*, July 5, 1880, p. 291.
42. *Deutsche Medicinische Wochenschrift*, No. 9, 1881, p. 116.
43. *Deutsche Medicinische Wochenschrift*, No. 19, 1880, p. 258.
44. *Centralblatt für Nervenheilkunde*, No. 21, 1880, p. 441.
45. *L'Union Médicale*, No. 165, 1880, p. 973.
46. *Progrès Médical*, No. 52, 1880, p. 1054.
47. *Chicago Medical Review*, February 20, 1881, p. 88.
48. *Medical Herald*, March, 1881, p. 502.